EXHIBIT 2
DATE 2-6-07
HB 360

AUDIO EVIDENCE LAB

Forensic Audio/Video Analysis
201 Cordoba Court
Arlington, Texas 76014

Barry G. Dickey, DABRE

To: Joe E. White, Jr
White & Weddle
5532 N. Western
Oklahoma City, OK 73118

Date of Report: 2/16/2006

RE: Forensic Analysis – In The Matter Of Brandon Patch.

Expert Report

I am Barry G. Dickey, an expert retained by Plantiff's attorney Joe E. White in the above captioned action. In my capacity as a forensic expert, I have assessed the authenticity and integrity of specific audio and/or video media identified in this report. Pursuant to Federal Rule of Civil Procedure 26(a)(2), I am submitting this report on behalf of White & Weddle as a summary of the opinions that I may express at the trial of this action. I reserve the right to modify, amend, and/or supplement this report in the future.

Qualifications:

My field of specialty is the forensic evaluation and authentication of analog and digital media, including analysis of audio and video originals and reproductions. I have been certified as a forensic expert by The New York Institute of Forensic Audio and am designated as a Diplomate of the American Board of Recorded Evidence. Additionally, I am a member of the American College of Forensic Examiners and the Audio Engineering Society. Since 1993, I have consulted as a forensic expert in over 1000 civil or criminal matters. Attached as Exhibit "B" is further information concerning my qualifications, including a list of cases in which I have provided expert reports, trial or deposition testimony during the past four years.

Compensation:

My services in this dispute are compensated pursuant to the fee schedule available through the counsel of White & Weddle, representing the Plantiff. None of my compensation is contingent in anyway upon the outcome of this matter or upon the opinions or positions I adopt or express. Further, to the best of my knowledge, I do not, nor have I ever, known or had any prior knowledge of or relationship with any individual related hereto.

Respectfully yours,

Barry G. Dickey, DABRE
Certified Forensic Analyst

817-417-0778 Voice Email: BDforensic@aol.com 817-472-5342 Fax

Between 1/25/2006 and 1/26/2006, I conducted an examination on QA-1. QA-1 was received from White and Weddle. Basic information associated with the recording was provided. Instructions were to analyze the audio contained on the digital disc and render an opinion associated with the elements/events; specifically, the identification of individual events and their associated time domain parameters. Further evaluations were conducted between 2/9/2006 and 2/13/2006. No equipment or recorders were provided for this examination. The results of my examinations are set forth below.

Exhibits Examined:

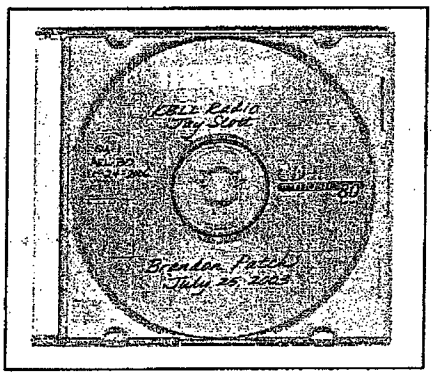
QA-1: Maxell CD-R 700 MB/80 min Digital Disc, Lot No. 3M449N5940580 {80 PD13160}. Labeled w/notations: "KBLL Radio" ▪ "Jay Scott" ▪ "Brandon Patch" ▪ "July 25, 2003" ▪ AEL verification.

**No original recording device(s) or equipment was provided for this examination.

Documents Reviewed:

No laboratory reports, testimony, or depositions were reviewed for this examination.

QA-1: PATCH



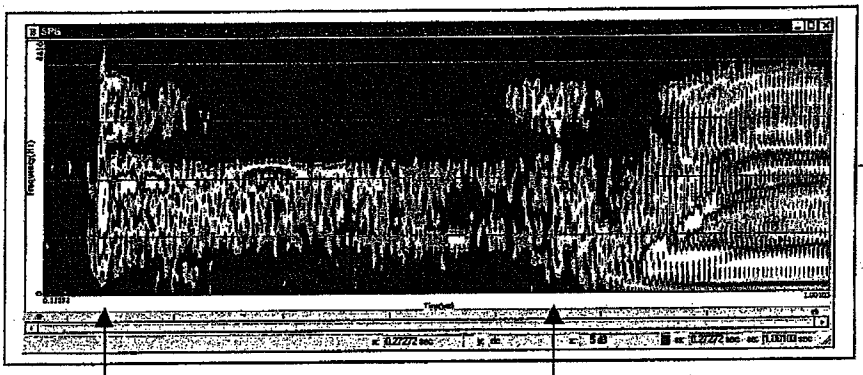
Results:

Examination of QA-1 disclosed events consistent with the basic representation. QA-1 contained continuous audio. The initial identification of two (2) critical elements was noted. The elements/events consistent with impact of ball w/bat and the impact of ball w/player (more specifically defined as pitcher) were considered. Both critical elements were identifiable; however, further evaluation of the entire recording was required in order to evaluate all other transients contained therein. Utilizing each of the two (2) critical elements separately, a comparative analysis examined transients throughout the entire recording, regardless of placement. The purpose was to verify that the two (2) critical elements were unique in spectral content and placement, eliminating the possibility that they were the result of recording devices and/or equipment. An extensive audit of the foreground and background content was conducted. Each relative transient was evaluated relative to placement, spectral content, and level. Multiple events occurring consecutively were noted by average. Some speech parameters were noted due to the transient nature of specific phonetics. A complete listing of the transients examined is attached as Exhibit "A".

Examination of the recorded time domain (elapsed time) between the two (2) critical events was verified to be {00:00:00.424}. Further evaluation of the actual time domain associated with the recording involved the compensation for the arrival of sound which initiated from two (2) different locations, propagated through a common medium, and then was recorded/captured at a mutual point (the announcer's booth/microphone). The distances calculated were from (A) home plate to the announcers booth/microphone and (B) the pitcher's mound to the announcer's booth/microphone.

The measurements associated with the above referenced (A) and (B) as well as the temperature on the day in question were provided by White & Weddle and represented as accurate in order to calculate the actual time domain from contact of bat w/ball to contact of ball w/player.

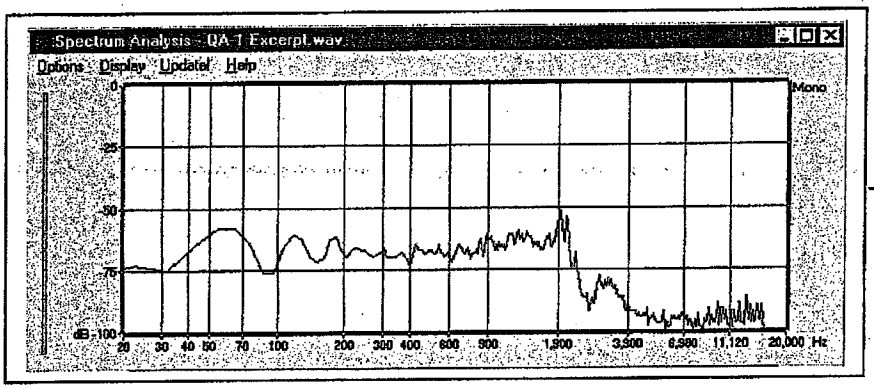
Distance from Pitcher's Mound to Announcer's Booth (B)	124.5 Ft
Distance from Home Plate to Announcer's Booth (A)	71.5 Ft.
Temperature on July 25, 2003 at 7:53 PM	84.0° F ▪ 28.9° C



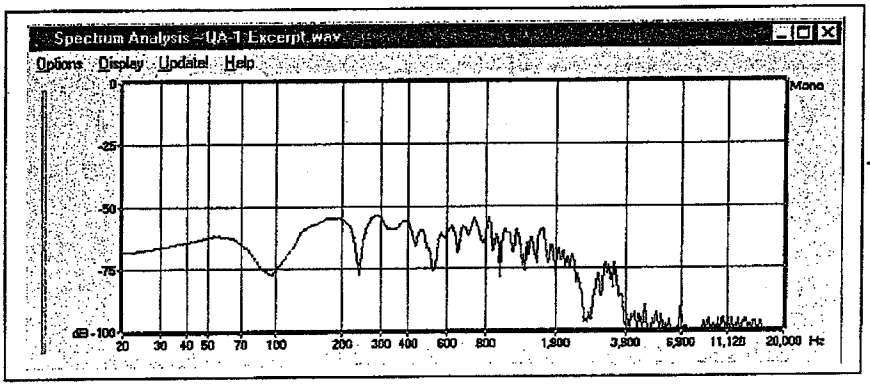
The spectrogram represents frequency content and recorded time domain associated with the two (2) critical events.

Contact with Bat
00:00:09.619

Contact with Player
00:00:10:044



This exhibit displays spectral information associated with bat/ball contact.



This exhibit displays spectral information associated with player/ball contact.

Methodology ▪ Time Domain: Calculation A

The speed of sound varies depending on the medium through which it is propagated. Therefore, the medium in this instance is air molecules. In conventional use and scientific literature sound velocity is the same as speed, more commonly referred to as the speed of sound in air. The most important atmospheric parameter which affects the speed of sound is temperature. The accepted standard for the speed of sound at 70° F is 1130 feet per second increasing at a rate of 1.1 foot per second for each degree Fahrenheit increase of temperature.

The temperature on 7/25/2003 at 7:53 PM was 84.0° F. Utilizing the accepted standards, the following calculations can be verified:

$$84.0° \text{ F} - 70° \text{ F} = 14° \text{ F}$$

$$14° \text{ F} \times 1.1 \text{ ft/s} = 15.4 \text{ ft/s}$$

$$15.4 \text{ ft/s} + 1130 \text{ ft/s} = 1145.4 \text{ ft/s}$$

Applying the result of these calculations to the scientifically accepted formula $\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$

Results in: $1145.4 = \frac{(124.5 - 71.5)}{\text{Time}} = \frac{53.0}{\text{Time}}$

Results in: $1145.4\ (\text{Time}) = 53.0$ $\qquad \text{Time} = \frac{53.0}{1145.4} = .04627 \text{ sec.}$

The calculations result in {0.04627} of a second delay relative to the pitcher's mound in comparison to the arrival of sound from home plate. Subtracting the delayed arrival time {0.04627} from the recorded time domain {0.424} would yield an actual time of approximately {0.37773}.

Methodology ▪ Time Domain: Calculation B

The speed of sound in dry air can also be approximated through the following equation. This equation is based on degrees celsius rather than degrees fahrenheit. Utilizing this optional formula, comparison of the results in Calculation A can provide a basis for opinion.

$$V = [\,331.4 + 0.6\text{Tc}\,] \text{ m/s} = [\,331.4 + 0.6\ (28.9° \text{ C})\,] \text{ m/s}$$

$$V = [\,331.4 + 17.34\,] \text{ m/s} = 348.74 \text{ m/s} = 1143.9 \text{ ft/s}$$

Results in: $1143.9 = \frac{(124.5 - 71.5)}{\text{Time}} = \frac{53.0}{\text{Time}}$

Results in: $1143.9\ (\text{Time}) = 53.0$ $\qquad \text{Time} = \frac{53.0}{1143.9} = .04633 \text{ sec.}$

The calculations result in {0.04633} of a second delay relative to the pitcher's mound in comparison to the arrival of sound from home plate. Subtracting the delayed arrival time {0.04633} from the recorded time domain {0.424} would yield an actual time of approximately {0.37767}.

Conclusion:

It is my opinion, based on the examination of the evidence provided, that QA-1 does contain events that are consistent with the contact of the bat with the ball and the contact of the ball with the player/pitcher. The comparative analysis of transients throughout the recording did not disclose any basis or anomaly which would question this identification. Additionally, the recorded time of 00:00:00.424 does not reflect the actual time domain since the recording captured individual events located at unequal distances. Averaging the results of the two (2) mathematical evaluations yield an estimated actual time domain of {0.37770}. This is the elapsed time between the ball striking the bat and the ball striking the player/pitcher.

Remarks: All original evidence and materials made available for the purpose of this report have been returned to Mr. Joe E. White, Jr. of White & Weddle. If testimony is anticipated, please provide immediate notice in order for preparation of appropriate exhibits and materials.

EXHIBIT "A"

White & Weddle ▪ Brandon Patch Case

Time	Event
00:00:09.619	Transient - Contact w/bat
00:00:10:044	Transient - ball/player contact/injury
00:00:10.060	Announcer - relative to batter/swing
00:00:10.830	Announcer - reaction to ball/player contact

Time	Level	Event
00:00:09.619	- 4.0	Spike/Transient - Contact w/bat
00:00:10:044	-15.4	Spike/Transient - ball/player contact/injury
00:00:05.014	- 25.1	Spike/Transient – multiple clapping – average
00:00:50.655	- 13.5	Transient – low freq spectral content – during speech
00:01:15.295*	- 33.8	Transient – prior to speech
00:01:27.349	- 31.1	Transient – noise floor
00:01:45.225	- 27.9	Plosive – Low freq spectral content
00:01:55.871	- 29.2	Transient – noise floor
00:02:02.130	- 27.3	Transient – noise floor
00:02:13.071	- 29.3	Transient – noise floor
00:02:22.582*	- 28.8	Transient – during speech – end word
00:02:34.978	- 22.4	Transient – during speech – beginning word
00:02:48.085*	- 26.1	Transient – prior to speech
00:03:15.069	- 14.4	Transient/plosive – low freq spectral content - beginning word
00:03:27.610	- 7.5	Plosive
00:03:56.761	- 28.5	Transient – noise floor – multi – average
00:04:06.043	- 24.3	Transient – noise floor – multi – average
00:04:20.898	- 28.6	Transient – noise floor
00:04:32.679	- 24.5	Transient – noise floor
00:04:33.040	- 22.0	Transient – noise floor
00:04:43.646	- 31.5	Transient – noise floor
00:05:01.761*	- 27.4	Transient – prior to speech
00:05:19.918	- 15.3	Transient – noise floor – during speech

Time Domain	Event
00:00:00.424	Contact w/bat to contact w/player (recorded time - not actual time)
00:00:00.441	Announcer - Delayed reaction to contact w/bat
00:00:00.770	Announcer - Delayed reaction to injury

** Transients examined immediately prior to speech or in noise floor inconsistent with injury event.
** Contact of bat w/ball contains unique spectral content/relative position in time domain.
** Injury event contains unique spectral content/relative position in time domain.

EXHIBIT "B" ▪ CURRICULUM VITAE

Barry G. Dickey, DABRE
Audio Evidence Lab
Forensic Audio/Video Analysis
201 Cordoba Court
Arlington, TX 76014-3169

November 1, 2005

EDUCATION:

University Of Texas – Arlington (1982 – 1984)

Western Kentucky University (1999, 2000, 2001, 2003)
Department of Continuing Education
New Jersey Institute For Forensic Audio/Video

CERTIFICATION:

The New York Institute of Forensic Audio (2000)
Expert Certification ▪ Forensic Audio

The American Board of Recorded Evidence (2001)
The American College of Forensic Examiners

The New York Institute Of Forensic Audio (2003)
Expert Certification ▪ Forensic Video

The New York Institute Of Forensic Audio (2003)
Expert Certification ▪ Forensic Voice Identification

CERTIFICATES OF ACHIEVEMENT:

The New York Institute of Forensic Audio (1999)
Forensic Audio/Video Authenticity

The New York Institute of Forensic Audio (2000)
Forensic Audio/Video Authenticity & Voice Identification

Voice Identification Inc. (2000)
Voiceprint Identification Techniques

The New York Institute of Forensic Audio (2001)
Forensic Audio, Forensic Video & Voice Identification

CERTIFICATES OF ACHIEVEMENT:

The New York Institute of Forensic Audio (2003)
Forensic Audio, Forensic Video & Voice Identification

The New York Institute of Forensic Audio (2003)
Advanced Voiceprint Identification Techniques

FORENSIC EXPERIENCE:

Examined 475+ Cases involving Digital Enhancement/Restoration of Audio/Video

Examined 425+ Cases Involving Piracy/Copyright Infringement

Examined 175+ Cases Involving Voice Identification/Elimination

Examined 325+ Cases involving Authenticity issues of Falsification/Tampering

US Government, State and District Attorneys, Corporate Law Firms, Civil and Criminal Attorneys, Private Investigators, and News Broadcast Agencies.

BACKGROUND:

Barry G. Dickey is the certified forensic expert for Audio Evidence Lab, a laboratory specializing in the examination, production, and engineering of audio/video recordings. His responsibilities include audio/video authentication, digital enhancement/restoration, voice identification/elimination, analysis of acoustical/visual media, and transcription of audio/video recordings. In association with The American College of Forensic Examiners, Mr. Dickey has served as the Certified Chairman of Forensic Audio for the American Board of Recorded Evidence. Since 1993, he has provided forensic analyses relative to criminal and civil cases for the US Government, State and District Attorneys, Corporate Law Firms, State and Federal Law Enforcement, Civil and Criminal Attorneys, Private Investigators, Insurance Companies, and News Broadcast Agencies. Utilizing DSP technology, analytical equipment, and microscopic resolution, Mr. Dickey employs scientifically accepted techniques to provide the critical evidence required in the courtroom.

Forensic cases involving Mr. Dickey have been featured on The Learning Channel's "Science Frontiers", "Forensic Files", CBS, and Fox News Networks. He has consulted with news networks in reference to the "Osama bin Laden Tapes" as well as other tapes released through foreign news networks. He has examined evidence relative to civil and criminal matters in over 1000 cases in the USA and Europe. He has testified on issues involving both audio and video evidence. He has over 20 years of experience in the engineering and production of audio and video recordings.

ORGANIZATIONS:

American College Of Forensic Examiners ▪ ACFE
American Board of Recorded Evidence ▪ ABRE
Audio Engineering Society ▪ AES
Certified Board Member ▪ ACFE/ABRE

TRAINING:

Law And Forensic Examination (2003)
The American College Of Forensic Examiners

Professional Ethics in Forensic Examination (2003)
The American College Of Forensic Examiners

Forensic Audio/Video Authenticity (1999)
The New York Institute of Forensic Audio

Scientific Evidence and Applied Forensic Science (2003)
The American College Of Forensic Examiners

Forensic Audio/Video Authenticity & Voice Identification (2000)
The New York Institute of Forensic Audio

Voiceprint Identification Techniques (2000)
Voice Identification Inc.

Forensic Audio, Forensic Video & Voice Identification (2001)
The New York Institute of Forensic Audio

Advanced Forensic Audio, Video & Voice Identification (2001)
The New York Institute of Forensic Audio

Forensic Audio, Forensic Video & Voice Identification (2003)
The New York Institute of Forensic Audio

Advanced Voiceprint Identification Techniques (2003)
The New York Institute of Forensic Audio

TRIALS, DEPOSITIONS AND EXPERT REPORTS:

Transamerican Natural Gas Corporation v. El Paso Natural Gas Company, Meridian Oil Inc., Burlington Resources Inc., Richard M. Bressler, Travis H. Petty, William A. Wise, Oscar S. Wyatt, The Coastal Corporation, and Coastal Oil and Gas Corporation (2000)
101st Judicial District Court of Dallas County, Texas

TRIALS, DEPOSITIONS AND EXPERT REPORTS:

State Of Texas Vs. Darlie Lynn Routier (1997-2000)
Criminal District Court 3, Dallas County, Texas

USA Vs. Argie Pruitt (1999)
United States District Court

K-Tel International, Inc., K-Tel International, Inc. d/b/a Commonwealth Music, Inc., The Ernest Evans Corporation, and Dominion Entertainment, Inc. Vs. San Juan Music Group, LTD., Musicrent, Inc., and Jay H. Chernow, Individually (1996)
United States District Court of New Jersey

Wilmer-Hutchins Independent School District Trustees vs. Schwartz & Eichelbaum, P.C. (2000)
191st J.D. Court, Dallas County, Texas

USA vs. Chistopher Breen (1997)
United States District Court for Western District Of New York

Paulino Zavala v. City Of Houston (2000)
United States District Court of Harris County

State Of Texas v. Alvi (2000)
United States District Court of Harris County

State of Texas v. Fred Marshall Davis (2001)
411th J.D. Court, San Jacinto County, Texas

PLS {Hudgins} v. City of Corpus Christi (2001)

Debra R. Nelsen v. Dale C. Bullough, et al. (2001)
County Court at Law No. 5, Dallas County, Texas

Gerald J. Mansour, Sr. v. Outback Steakhouse of Dallas-I, Ltd (2001)
95th Judicial District Court of Dallas County, Texas

Paula Sage v. Citicasters Co., and Bubba The Lovesponge Clem (2001)
United States District Court for the Western District of Oklahoma

Martin Mathew v. Park Place LX of Texas, et al. (2001)
95th District Court; Dallas County, Texas

State of Louisiana Versus #355225 B. J. Dantin (2001)
17th Judicial District, Parish Of Lafourche, Louisiana

Federal Mediation and Conciliation Service (2001)
United States Government Offices, Washington, D.C.

TRIALS, DEPOSITIONS AND EXPERT REPORTS:

Estate of Troy James Davis v. City Of North Richland Hills; Chief of Police Tom Shockley; Officer Allen L. Hill; Officer J. A. Wallace; Officer Curtis Westbrook; Officer Gregory Crane; Unknown Personnel Of The North Richland Hills Police Department (2001)
United States District Court for the Northern District of Texas

Brent Paternostro v. Crescent City Connection (2002)
United States District Court No: 00-2740

State of Texas v. Solis-Yepez (2002)
United States District Court

Herrington Equipment, Inc. and Robert N. Herrington vs. Orix Credit Alliance, Inc. n/k/a Orix Financial Services, Inc. (2002)
United States District Court for the Southern District of Texas

Hopethan Johnson Case – Missing Person/Homicide (2002)
York County Police Department, City of York

Commonwealth of Pennsylvania v. Zachary Paul Witman (2001)
Court of Common Pleas, Criminal Division, York County

State of Texas v. Jesse Harold Mauldin (2002)
United States District Court, Smith County

State of Texas v. Johnny Howard Mauldin (2002)
United States District Court, Smith County

State of Texas v. Chris Young (2002)
United States District Court, Smith County

State of Texas v. Lawrence A. Bullette (2002)
United States District Court, Smith County

U.S.A. v. Juan Rubalcaba (2002)
SA: 02-CR-480(2)-OG

State of Texas v. Johnnie L. Davis (2003)
177th District Court of Harris County, State of Texas

Jefferson Davis McGee v. Maricopa County; Joseph M. Arpaio and Ava Arpaio; Officer John Doe Tarango and Jane Doe Tarango; Officer John Doe Murphy and Jane Doe Murphy; Officer Micheal Crane and Jane Doe Crane; Sgt. Jane Doe Nowicki and John Doe Nowicki; Capt. Tracy Haggard and John Doe Haggard; Black & White Corporations 1-10; and John and Jane Does 1-10 (2002)
The Superior Court of Maricopa County, State of Arizona

TRIALS, DEPOSITIONS AND EXPERT REPORTS:

Baybasin v. The State (2003)
Netherlands Supreme Court

Dallas County Board of Education v. Barbera J. Barge (2002)
District Court, Dallas County, Texas

Universal Surveillance Systems v. Sensormatic Electronics Corporation (2003)
United States District Court, Southern District of Florida

State of Texas v. Jerry Jackson (2003)
District Court, City of Jefferson, Texas

Bill Burch and International Mercantile, Inc v. Nextel Communications, Inc. and Nextel of Texas, Inc. (2003)
Arbitration Proceeding – The American Arbitration Assoc., Dallas,Texas

United States v. Schneider (2003)
United States District Court for The Western District of Oklahoma

Teresa Mae Scott, Individually and Toby Michael Scott, a representative of the Estate of Gregory Stephen Scott, Deceased. v. Zale Lipschy University Hospital, Zenobia Hubbard, R.N. and Shelly Thorpe, R.N. (2003)
In the District Court; 14th Judicial District, Dallas County, Texas

Iron Mountain Inc. v. J. Peter Pierce, Sr. (2003)
ADR Options, State of Pennsylvania

State of Texas v. Gabriel Cuauhtli (2003)
In the Criminal District Court 3, Tarrant County, Texas

David Theiff v. Kari Halen (2003)
In the 9th Judicial Court of the State of Nevada, County of Douglas

State of Texas v. Beverly Cropp (2004)
Criminal District Court, Tarrant County, Texas

State of Texas v. Stephen Armstrong (2004)
In the Criminal District Court 1, Tarrant County, Texas

Jerry Harrison v. Hallmark Toyota-BMW, Inc. (2004)
Circuit Court of Hinds County, State of Mississippi

State of Texas v. Jermaine Thomas (2004)
In the District Court, 208th Judicial District, Harris County, Texas

State of Texas v. Marc Latham (2004)
In the Criminal District Court, Tarrant County, Texas

TRIALS, DEPOSITIONS AND EXPERT REPORTS:

Twillita Webb v. CareFirst, Inc. (2004)
Superior Court of the District of Columbia, Civil Division

State of Texas v. Raul Ramirez (2004)
In the 178th Judicial District Court of Harris County, Texas

State of Indiana v. David Maust (2004)
Superior Court of Lake County, Criminal Division, Indiana

Mary Thompson v. Unique Digital, Inc. (2004)
In the 61st Judicial District Court of Harris County, Texas

United States v. Breion Jamar Green (2004)
In the United States District Court for the Western District of Texas

State of Texas vs. Tanner Anderson Sartin
In the 149th District Court of Brazoria County, State of Texas

State of Texas vs. Andre Washington (2005)
In the 208th Judicial District Court of Harris Couty, Texas

Deborah J. Golder, Individually, as Heir of the Estate of Paul Silvas, and a/n/f of Paul Anthony Silvas and Jacob Celestino Silvas vs. The City of Corpus Christi (2005)
In the United States District Court for the Southern Distict of Texas

United States v. Joel Parra (2005)
In the United States District Court, District of Wyoming

State of Texas v. Kevin Rotenberry (2005)
In the 213th Judicial District Court, Tarrant County, Texas

Mario Alberto Medrano vs. Tommy B. Thomas (2005)
In the U.S. District Court for the Southern District of Texas, Houston Division

State of Texas vs. Timothy White (2005)
In the Criminal District Court No. 3, Tarrant County, Texas

Titon International v. United Steel Union (2005)
In the Judicial Central District, State of Illinois

State of Texas vs. Javier Sabillon (2005)
In the 372nd Criminal District Court, Tarrant County, Texas

State of Texas vs. Keith Cumbee (2005)
In the District Court of Smith County, State of Texas

TRIALS, DEPOSITIONS AND EXPERT REPORTS:

State of Oklahoma vs. Stephen Smith (2005)
In the Criminal District Court, State of Oklahoma

State of Texas vs. Dawn Reiser (2005)
In the Criminal District Court No. 2, Tarrant County, Texas

State of Mississippi vs. Joey Carroll (2005)
In the United States District Court, State of Mississippi

State of Texas vs. Edison Jaramillo (2005)
In the Criminal District Court Of Harris County, Texas

State of Florida vs. Mark Jude Frisch (2005)
In the Circuit Cout of the Seventh Judicial Circuit, In and for Volusio County, Florida

State of Texas vs. Steven Craig White (2005)
In the 4th Criminal District Court of Tarrant County, Texas

People of the Virgin Islands vs. Muntaser N. Rahman (2005)
In the Criminal Court, Virgin Islands of the United States

State of Texas vs. Ebony Maebery (2005)
In the District Court, 212th Judicial District, Galveston County, Texas

United States vs. Bobby Wayne Haley, Jr. (2005)
In the United States District Court, In and for the Northern District of Oklahoma

EMPLOYMENT:

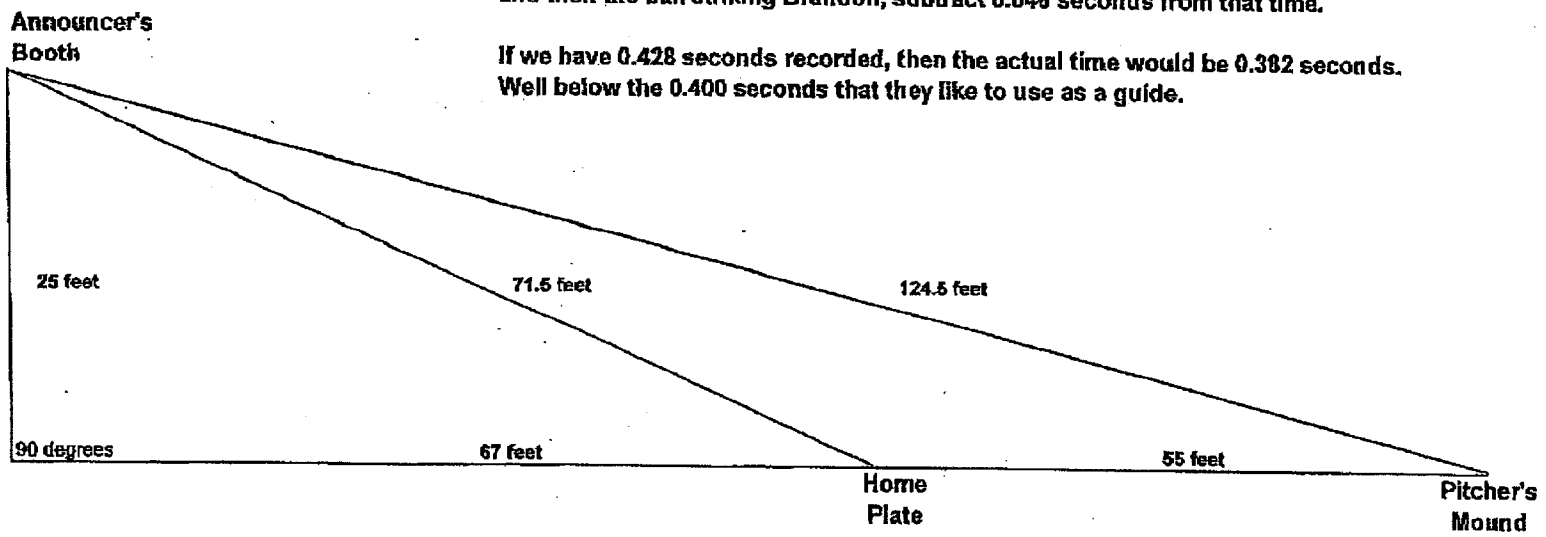
1999 – Present	Audio Evidence Lab	Forensic Analyst - Audio/Video Lab
1989 – 1999	Graffiti Productions, Inc.	President - Graffiti Productions, Inc. - Graffiti Records - Writing on The Wall Music {BMI} Analyst/Engineer - Forensic Dept Mix Engineer - Control Room A Consultant - Facility Design/Install
1986 – 1989	True Colours Recording Studio	Mix Engineer - Control Room A & B - Midi/Pre-production Producer/Arranger - Production Staff Consultant - Facility Design/Install
1984 – 1986	Sound Concepts	Mix/Tracking Engineer - Control Room A, B, & C Producer/Arranger - Production Staff Technician - Pro Audio Support & Install

Feet	Distance from Announcer's Booth to:
124.5	Pitcher's Mound
71.5	Home Plate
53	feet longer from Pitcher's Mound compared to Home Plate.

$$\frac{\text{53 feet in difference}}{\text{1,144.49 feet per second Speed of Sound}} = \text{0.046 seconds}$$

Whatever the total time recorded from the CD from when the ball is hit by the bat and then the ball striking Brandon, subtract 0.046 seconds from that time.

If we have 0.428 seconds recorded, then the actual time would be 0.382 seconds. Well below the 0.400 seconds that they like to use as a guide.



My numbers were taken from a rough measurement, but reviewing the difference in distance in the hypotenuse, the accurate numbers once measured will not significantly decrease the time of 0.046 seconds

Again, little things like how close was the batter to the front of the plate, how high was the bat when it struck the ball, how far was Brandon's head from the pitcher's mound and how high was Brandon's head once struck may come into play. This is information that we could get from the video to review Brandon's average stride and height and the batter did foul a ball just before the fatal hit. But again I believe that this information would not significantly change the 0.046 seconds.

Speed of Sound in Air

The speed of sound in dry air is given approximately by

$$v_{sound\ in\ air} \approx 331.4 + 0.6T_C \ \ m/s$$

where T_C is the celsius temperature.

so that at temperature 28.9 C = 84.02 F,

the speed of sound is 349.029 m/s = 1145.108 ft/s = 781.8249 mi/hr.

This calculation is usually accurate enough, but for great precision one must examine the more general relationship for sound speed in gases. This sound speed does not apply to gases other than air, for example the helium from a balloon.

It is important to note that the sound speed in air is determined by the air itself. It is not dependent upon the sound amplitude, frequency or wavelength.

Speed of sound

rom Wikipedia, the free encyclopedia

Sound measurements
Sound pressure p
Sound pressure level (SPL)
Particle velocity v
Particle velocity level (SVL)
(Sound velocity level)
Particle displacement ξ
Sound intensity I
Sound intensity level (SIL)
Sound power P_{ac}
Sound power level (SWL)
Sound energy density E
Sound energy flux q
Acoustic impedance Z
Speed of sound c

he **speed of sound** c (from Latin *celeritas*, "velocity") varies depending on the medium through hich the sound waves pass. It is usually quoted in describing properties of substances (e.g. see the rticle on sodium). In conventional use and in scientific literature sound velocity v is the same as ound speed c. Sound velocity c or velocity of sound should not be confused with sound particle elocity v, which is the velocity of the individual particles.

lore commonly the term refers to the speed of sound in air. The speed varies depending on tmospheric conditions; the most important factor is the temperature. The humidity has very little ffect on the speed of sound, while the static sound pressure (air pressure) has none. Sound travels lower with an increased altitude (elevation if you are on solid earth), primarily as a result of emperature and humidity changes. An approximate speed (in metres per second) can be calculated om:

$$c_{air} = (331.5 + (0.6 \cdot \theta))\ \mathrm{m/s}$$

here θ (theta) is the temperature in degrees Celsius.

$\theta = 28.9\,C$

$(331.5 + (0.6 \times 28.9))$ m/s

$(331.5 + (17.34))$ m/s

348.84 m/s = 1,144.49 ft/sec.

History for Helena, Montana
on Friday, July 25, 2003

Jump to data by:

Date: July 25 2003 Airport Code: Go

Latest visited Airport Codes: KHLN

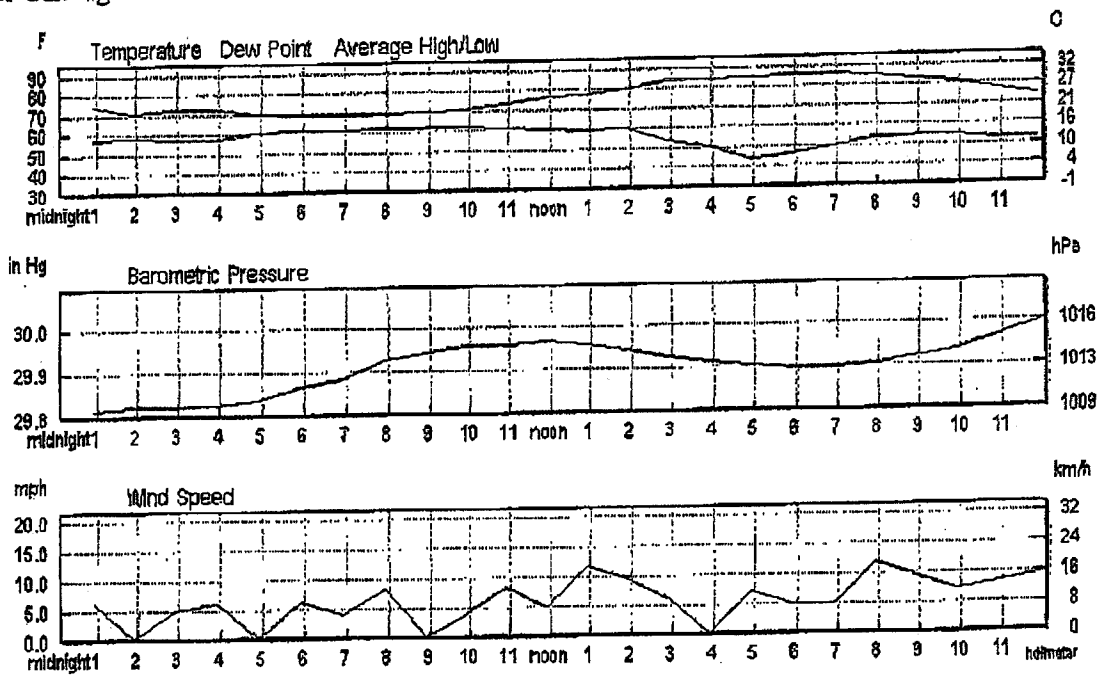
« Previous Day **Daily** | Weekly | Monthly | Custom | Trip Planner Next Day »

Daily Summary

	Actual	Average	Record
Temperature			
Mean Temperature	76 °F / 24 °C	69 °F / 20 °C	
Max Temperature	87 °F / 30 °C	85 °F / 29 °C	99 °F / 37 °C (1933)
Min Temperature	66 °F / 18 °C	53 °F / 11 °C	44 °F / 6 °C (1918)
Degree Days			
Heating Degree Days	0	1	
Month to date heating degree days		38	
Since 1 July heating degree days		38	
Cooling Degree Days	11	5	
Month to date cooling degree days		97	
Year to date cooling degree days		139	
Growing Degree Days	26 (Base 50)		
Moisture			
Dew Point	56 °F / 13 °C		
Average Humidity	53		
Maximum Humidity	78		
Minimum Humidity	24		
Precipitation			
Precipitation	0.00 in / 0.00 cm	0.04 in / 0.10 cm	0.73 in / 1.85 cm (1993)
Month to date precipitation		1.10	
Year to date precipitation		7.14	
Snow			
Snow	0.00 in / 0.00 cm	-	0
Month to date snowfall			
Snow Depth	-		
Sea Level Pressure			
Sea Level Pressure	29.89 in / 1012 hPa		
Wind			
Wind Speed	4 mph / 6 km/h (WNW)		
Max Wind Speed	12 mph / 19 km/h		
Max Gust Speed	-		
Visibility	10 miles / 16 kilometers		
Events	Rain		

Key: T is trace of precipitation, MM is missing value

Source: NWS Daily Summary



Show full METARS (help) - Comma Delimited File

Time (MDT)	Temperature	Dew Point	Humidity	Sea Level Pressure	Visibility	Wind Direction	Wind Speed	Gust Speed	Precipitation	Events	Condition
12:53 AM	73.0 °F / 22.8 °C	55.9 °F / 13.3 °C	55%	29.81 in / 1009.4 hPa	10.0 miles / 16.1 kilometers	WNW	5.8 mph / 9.3 km/h	-	0.00 in / 0.0 cm		Overcast
1:53 AM	70.0 °F / 21.1 °C	57.0 °F / 13.9 °C	63%	29.82 in / 1009.7 hPa	10.0 miles / 16.1 kilometers	Calm	Calm	-	N/A		Scattered Clouds
2:53 AM	71.1 °F / 21.7 °C	55.9 °F / 13.3 °C	59%	29.82 in / 1009.6 hPa	10.0 miles / 16.1 kilometers	NW	4.6 mph / 7.4 km/h	-	N/A		Overcast
3:53 AM	71.1 °F / 21.7 °C	55.9 °F / 13.3 °C	59%	29.82 in / 1009.8 hPa	10.0 miles / 16.1 kilometers	West	5.8 mph / 9.3 km/h	-	N/A		Mostly Cloudy
4:53 AM	69.1 °F / 20.6 °C	59.0 °F / 15.0 °C	70%	29.83 in / 1009.9 hPa	10.0 miles / 16.1 kilometers	Calm	Calm	-	0.00 in / 0.0 cm		Partly Cloudy
5:53 AM	68.0 °F / 20.0 °C	60.1 °F / 15.6 °C	76%	29.86 in / 1011.1 hPa	10.0 miles / 16.1 kilometers	WNW	5.8 mph / 9.3 km/h	-	0.00 in / 0.0 cm		Mostly Cloudy
6:53 AM	68.0 °F / 20.0 °C	60.1 °F / 15.6 °C	76%	29.88 in / 1011.8 hPa	10.0 miles / 16.1 kilometers	West	3.5 mph / 5.6 km/h	-	N/A		Overcast
7:53 AM	68.0 °F / 20.0 °C	61.0 °F / 16.1 °C	78%	29.92 in / 1013.1 hPa	8.0 miles / 12.9 kilometers	West	8.1 mph / 13.0 km/h	-	0.00 in / 0.0 cm	Rain	Light Rai
8:53 AM	69.1 °F / 20.6 °C	61.0 °F / 16.1 °C	75%	29.94 in / 1013.7 hPa	10.0 miles / 16.1 kilometers	Calm	Calm	-	0.00 in / 0.0 cm		Overcast
9:53 AM	70.0 °F / 21.1 °C	61.0 °F / 16.1 °C	73%	29.95 in / 1014.2 hPa	10.0 miles / 16.1 kilometers	West	3.5 mph / 5.6 km/h	-	N/A		Mostly Cloudy
10:53 AM	72.0 °F / 22.2 °C	60.1 °F / 15.6 °C	66%	29.95 in / 1014.1 hPa	10.0 miles / 16.1 kilometers	SSE	8.1 mph / 13.0 km/h	-	N/A		Overcast

11:53 AM	75.0 °F / 23.9 °C	59.0 °F / 15.0 °C	57%	29.96 in / 1014.5 hPa	10.0 miles / 16.1 kilometers	Variable	4.6 mph / 7.4 km/h	-	N/A	Overcast
12:53 PM	75.9 °F / 24.4 °C	57.9 °F / 14.4 °C	54%	29.95 in / 1014.2 hPa	10.0 miles / 16.1 kilometers	North	11.5 mph / 18.5 km/h	-	N/A	Overcast
1:53 PM	79.0 °F / 26.1 °C	59.0 °F / 15.0 °C	50%	29.94 in / 1013.9 hPa	10.0 miles / 16.1 kilometers	North	9.2 mph / 14.8 km/h	-	N/A	Clear
2:53 PM	82.9 °F / 28.3 °C	52.0 °F / 11.1 °C	34%	29.92 in / 1013.0 hPa	10.0 miles / 16.1 kilometers	Variable	5.8 mph / 9.3 km/h	-	N/A	Clear
3:53 PM	82.9 °F / 28.3 °C	50.0 °F / 10.0 °C	32%	29.91 in / 1012.8 hPa	10.0 miles / 16.1 kilometers	Calm	Calm	-	N/A	Clear
4:53 PM	84.0 °F / 28.9 °C	43.0 °F / 6.1 °C	24%	29.90 in / 1012.4 hPa	10.0 miles / 16.1 kilometers	Variable	6.9 mph / 11.1 km/h	-	N/A	Clear
5:53 PM	84.9 °F / 29.4 °C	45.0 °F / 7.2 °C	25%	29.89 in / 1012.2 hPa	10.0 miles / 16.1 kilometers	Variable	4.6 mph / 7.4 km/h	-	N/A	Clear
6:53 PM	84.9 °F / 29.4 °C	48.9 °F / 9.4 °C	29%	29.89 in / 1012.1 hPa	10.0 miles / 16.1 kilometers	Variable	4.6 mph / 7.4 km/h	-	N/A	Clear
7:53 PM	84.0 °F / 28.9 °C	52.0 °F / 11.1 °C	33%	29.90 in / 1012.4 hPa	10.0 miles / 16.1 kilometers	East	11.5 mph / 18.5 km/h	-	N/A	Clear
9:53 PM	80.1 °F / 26.7 °C	53.1 °F / 11.7 °C	39%	29.93 in / 1013.4 hPa	10.0 miles / 16.1 kilometers	SE	6.9 mph / 11.1 km/h	-	N/A	Clear
10:53 PM	75.9 °F / 24.4 °C	51.1 °F / 10.6 °C	42%	29.96 in / 1014.6 hPa	10.0 miles / 16.1 kilometers	NW	8.1 mph / 13.0 km/h	-	N/A	Clear
11:53 PM	73.9 °F / 23.3 °C	51.1 °F / 10.6 °C	45%	29.99 in / 1015.3 hPa	10.0 miles / 16.1 kilometers	WNW	9.2 mph / 14.8 km/h	-	N/A	Clear

Temperature

It's a Different Game

(**Part 8** – 2006 Season)

Aluminum Bat Performance - VS - Wood Bat Performance

December, 2006

Coach Bill Thurston
Asst. Coach Brian Hamm

This is the **8th** in a series of statistical studies comparing the performance of the high-tech aluminum bats to traditional wood bats. As in the previous 7 studies only **Division I hitters** and **pitchers** were included. Statistics were gathered from the official Cape Cod League publication and from statistical reports from the individual colleges to the NCAA. To qualify for the study, hitters had to have a minimum of 70 at bats in the Cape League; pitchers had to pitch a minimum of 25innings in the Cape. This means that only regular players were used for the study.

There were **102 Division I hitters** from 65 different programs and **71 pitchers** who met the criteria. This study compares the offensive performance of the same players, comparing their statistical performances using the aluminum bat during their college season to their performance statistics using the traditional wood bat in the Cape Cod League. Thus, **the comparison is for the same player during the same 2006 year, the major variable being the bat.**

The difference in offensive performance for 2006 from aluminum to the wood continues to be as dramatic as it has been for the previous 7 (seven) studies. Below is the comparison of 102 Division I hitters in six (6) offensive categories.

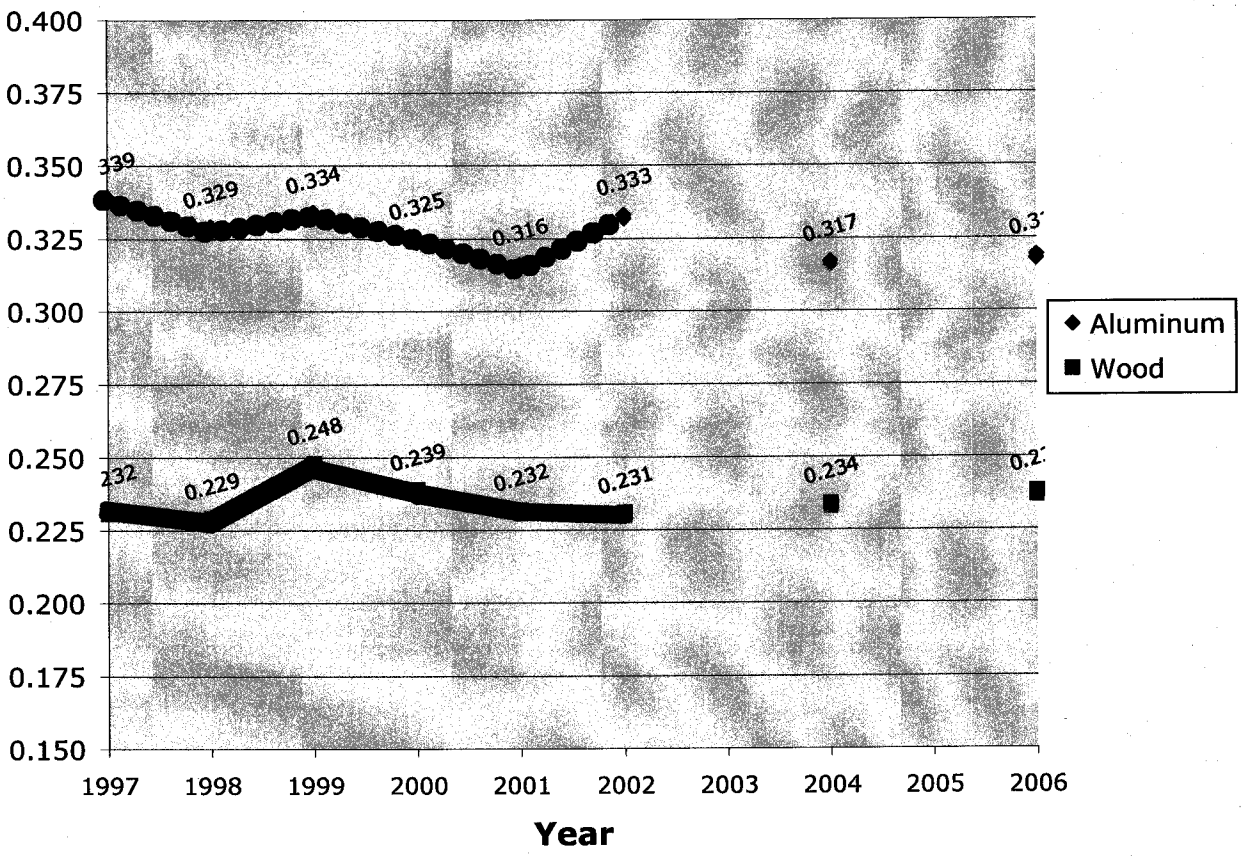
2006 STATS

Offensive Statistics	Hitters Using **Aluminum**	Hitters Using **Wood**	Difference Using Wood
I. Batting Average	.319	.238	**- .081 points**
II. Slugging Percentage	.476	.329	**- .147 points**
III. Home runs per at bat	1/38	1/68	**- 44%**
IV. Runs scored per at bat	1/ 4.7	1/ 8.1	**- 42%**
V. RBI per at bat	1/ 5.4	1/ 9.6	**- 44%**
VI. Strike out percentage	16%	23%	**+ 7%**

Of course, a one-year comparison is not a trend, but the 8 (eight) year totals dramatically demonstrate the difference in aluminum and wood bat performances in games. There is very little correlation from tests done in the lab and what happens when actual hitters swing the bat.

Even though some average and differences appear to be somewhat lower in 2006, in 5 of the 6 categories studied, the results were in the range of the previous 7 year averages. **It is obvious that there continues to be a major difference between the performance of aluminum and wood bats.**

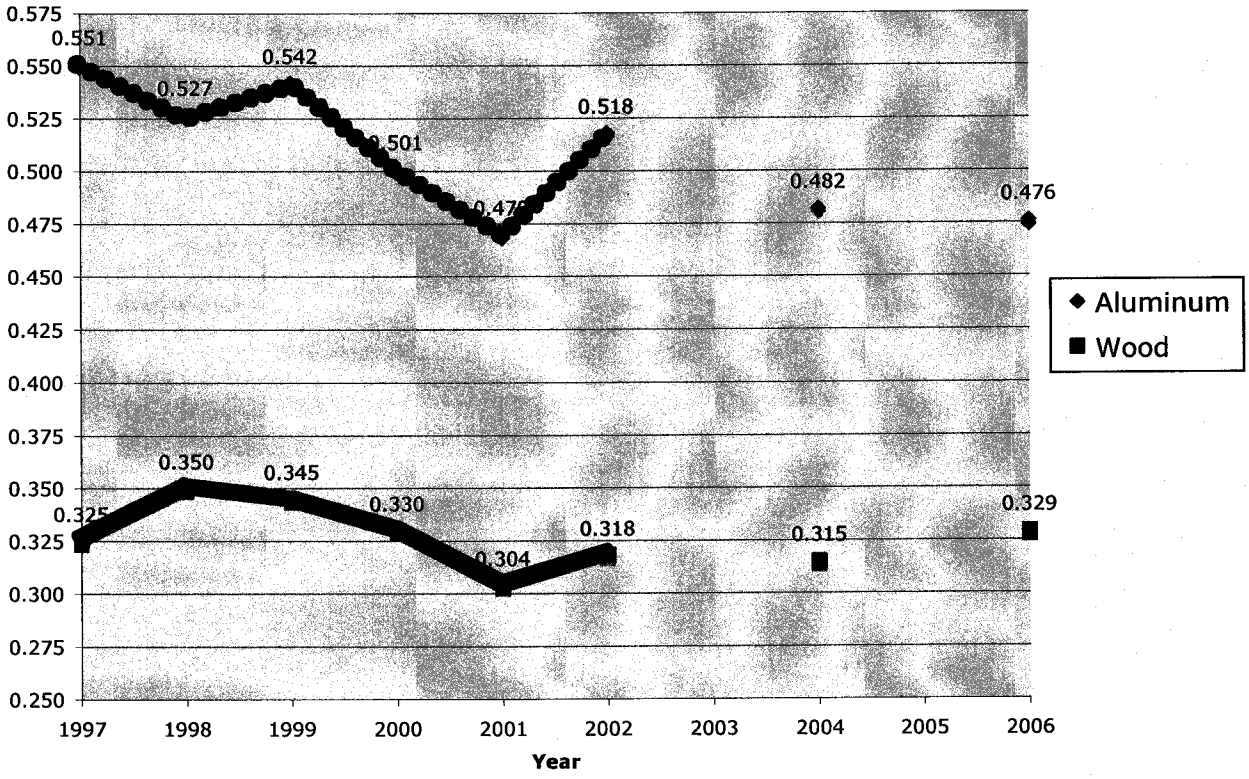
8 Season Trend
Comparison of Aluminum to Wood Bat Performance
By Batting Average



Year	Aluminum	Wood	Difference using wood
1997	.339	.232	-.107
1998	.329	.229	-.082
1999	.334	.248	-.086
2000	.325	.239	-.086
2001	.316	.232	-.084
2002	.333	.231	-.102
2003	-	-	-
2004	.317	.234	-.083
2005	-	-	-
2006	.319	.238	-.081
Approx. 8 Year Avg.	**.327**	**.235**	**-.089**

This study was not conducted in 2003 and 2005.

8 Season Trend
Comparison of Aluminum to Wood Bat Performance
By Slugging Percentage

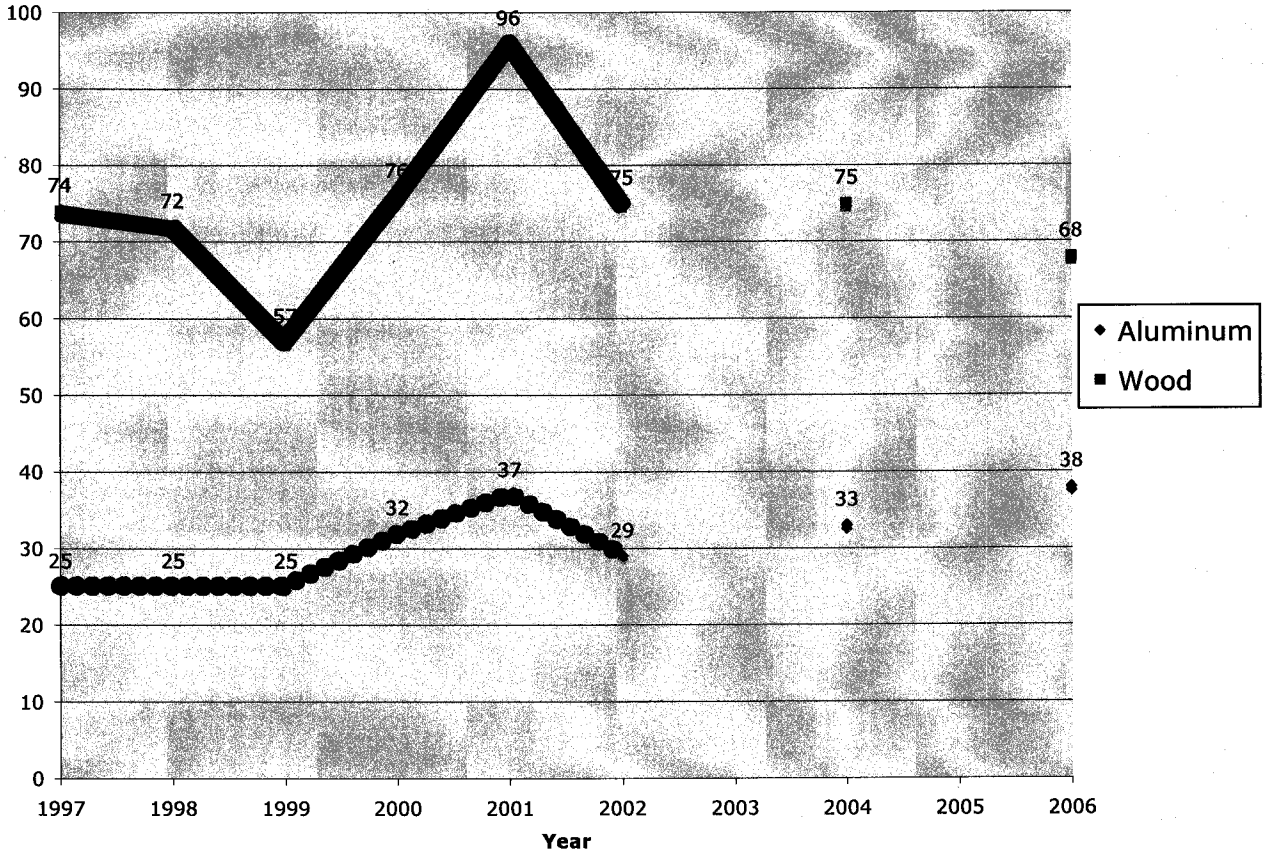


Slugging Percentage

Year	Aluminum	Wood	Difference using wood
1997	.551	.325	-.226
1998	.527	.350	-.177
1999	.542	.345	-.197
2000	.501	.330	-.171
2001	.470	.304	-.166
2002	.518	.318	-.200
2003	-	-	-
2004	.482	.315	-.167
2005	-	-	-
2006	.476	.329	-.147
Approx. 8 Year Avg.	**.508**	**.323**	**-.181**

This study was not conducted in 2003 and 2005.

8 Season Trend
Comparison of Aluminum to Wood Bat Performance
By Home Runs



Home Runs (per average number of at bats)

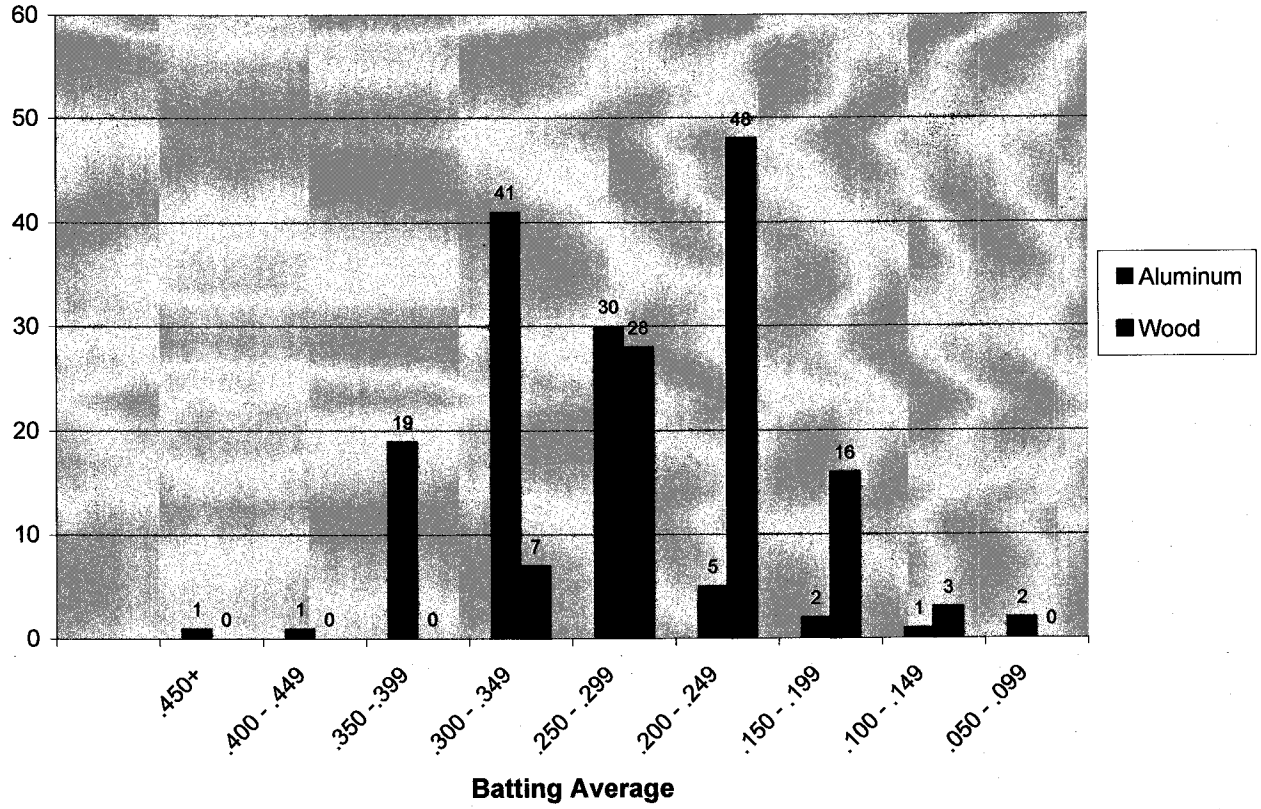
Year	Aluminum	Wood	Difference using wood
1997	1/25	1/74	-66%
1998	1/25	1/72	-65%
1999	1/25	1/57	-56%
2000	1/32	1/76	-58%
2001	1/37	1/96	-61%
2002	1/29	1/75	-61%
2003	-	-	-
2004	1/33	1/75	-56%
2005	-	-	-
2006	1/38	1/68	-56%
Approx. 8 Year Avg.	**1/30.5**	**1/74**	**-59%**

This study was not conducted in 2003 and 2005.

Comparison of Aluminum to Wood Bat Performance

By Batting Average

2006 Season



Batting Average	Aluminum		Wood	
	Hitters*	Percent	Hitters*	Percent
.450+	1	1%	0	0%
.400 - .449	1	1%	0	0%
.350 -.399	19	19%	0	0%
.300 - .349	41	40%	7	7%
.250 - .299	30	29%	28	27%
.200 - .249	5	5%	48	47%
.150 - .199	2	2%	16	16%
.100 - .149	1	1%	3	3%
.050 - .099	2	2%	0	0%

Using Aluminum:
- 5% batted below .200
- 62% batted over .300
- Highest batting average was .464

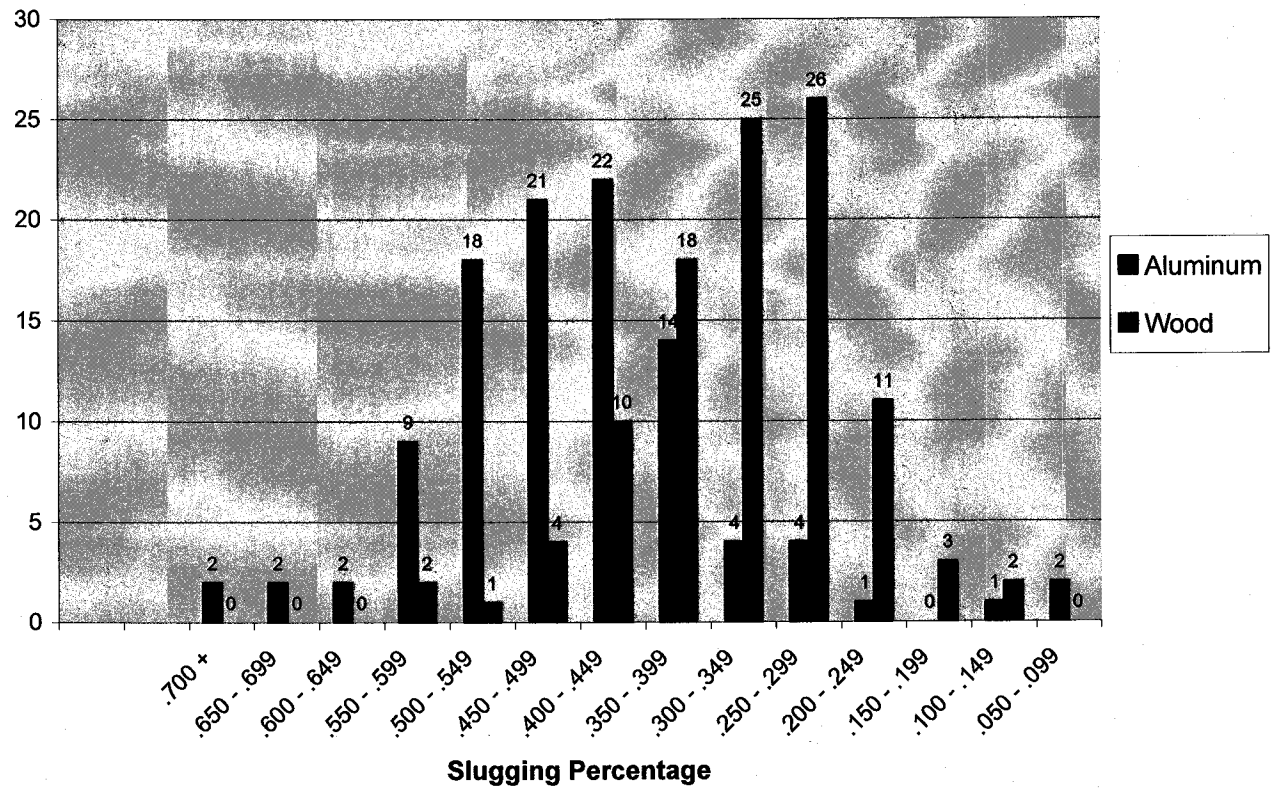
Using Wood:
- 19% of hitters batted below .200
- Only 7% batted over .300
- Highest batting average was .316

* Number of Hitters

Comparison of Aluminum to Wood Bat Performance

By Slugging Percentage

2006 Season



Slugging Percentage	Aluminum		Wood	
	Hitters	Percent	Hitters	Percent
.700 +	2	2%	0	0%
.650 - .699	2	2%	0	0%
.600 - .649	2	2%	0	0%
.550 - .599	9	9%	2	2%
.500 - .549	18	18%	1	1%
.450 - .499	21	21%	4	4%
.400 - .449	22	21%	10	10%
.350 - .399	14	14%	18	18%
.300 - .349	4	4%	25	24%
.250 - .299	4	3%	26	25%
.200 - .249	1	1%	11	11%
.150 - .199	0	0%	3	3%
.100 - .149	1	1%	2	2%
.050 - .099	2	2%	0	0%

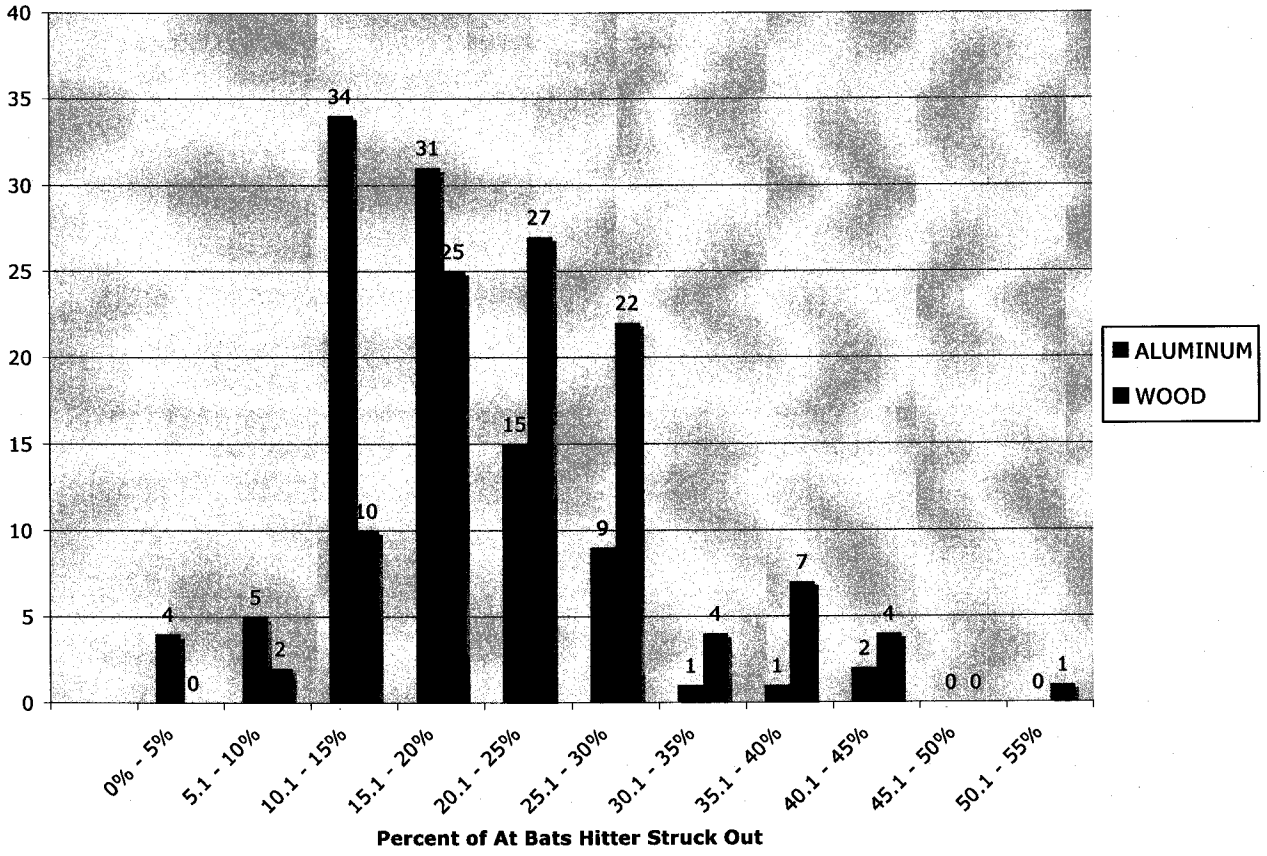
Using Aluminum:
- 75% had slugging percentage over .400
- 7% had slugging percentage under .300

Using Wood:
- 17% had slugging percentage over .400
- 42% had slugging percentage under .300

Comparison of Aluminum to Wood Bat Performance

By Strike Outs

2006 Season



Percent of At Bats Hitter Struck Out	Aluminum		Wood	
	Hitters	Percent	Hitters	Percent
0% - 5%	4	4%	0	0%
5.1 - 10%	5	5%	2	2%
10.1 - 15%	34	33%	10	10%
15.1 - 20%	31	30%	25	25%
20.1 - 25%	15	15%	27	26%
25.1 - 30%	9	9%	22	22%
30.1 - 35%	1	1%	4	4%
35.1 - 40%	1	1%	7	7%
40.1 - 45%	2	2%	4	4%
45.1 - 50%	0	0%	0	0%
50.1 - 55%	0	0%	1	1%

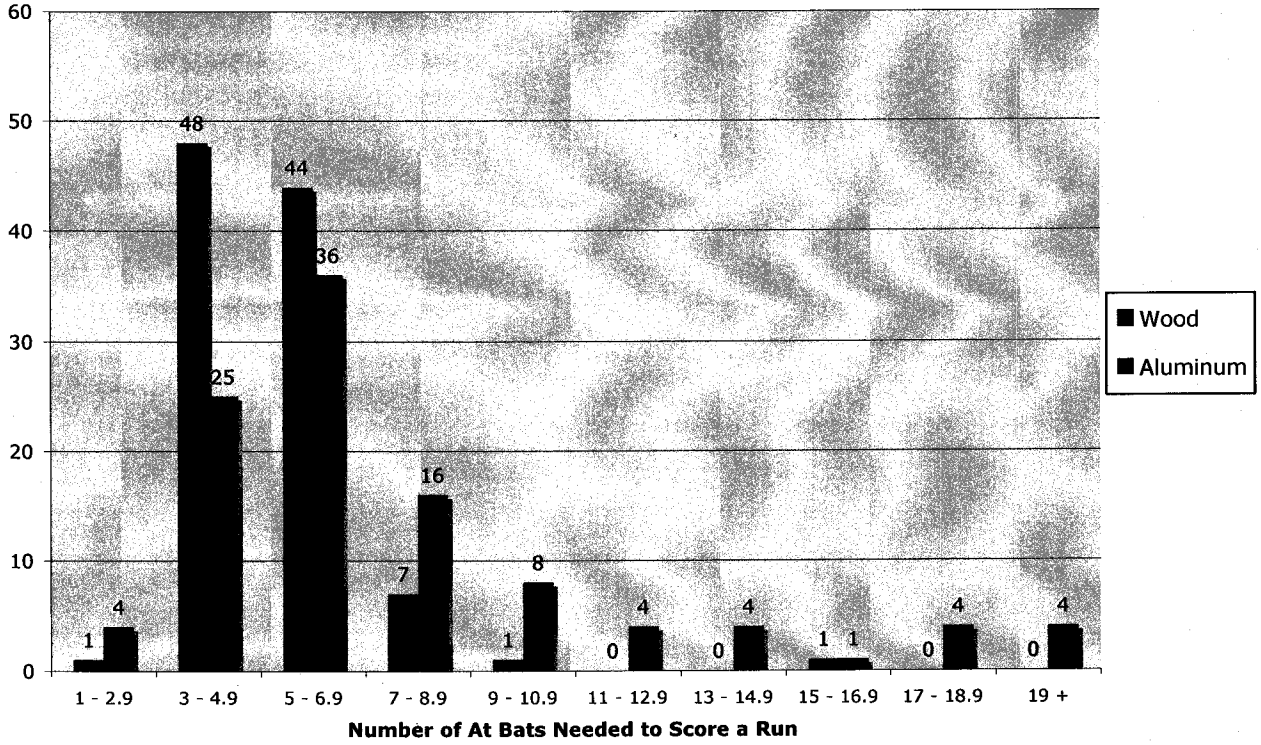
Using Aluminum:
- 13% of hitters struck out over 25%

Using Wood:
- 38% of hitters struck out over 25%

Comparison of Aluminum to Wood Bat Performance

By Runs Scored

2006 Season



At Bats Needed to Score a Run	Aluminum		Wood	
	Hitters	Percent	Hitters	Percent
1 – 2.9	1	1%	4	0%
3 – 4.9	48	47%	25	4%
5 – 6.9	44	42%	36	25%
7 – 8.9	7	7%	16	36%
9 - 10.9	1	1%	8	16%
11 - 12.9	0	0%	4	8%
13 - 14.9	0	0%	4	4%
15 - 16.9	1	1%	1	4%
17 - 18.9	0	0%	4	1%
1/19 +	0	0%	4	4%

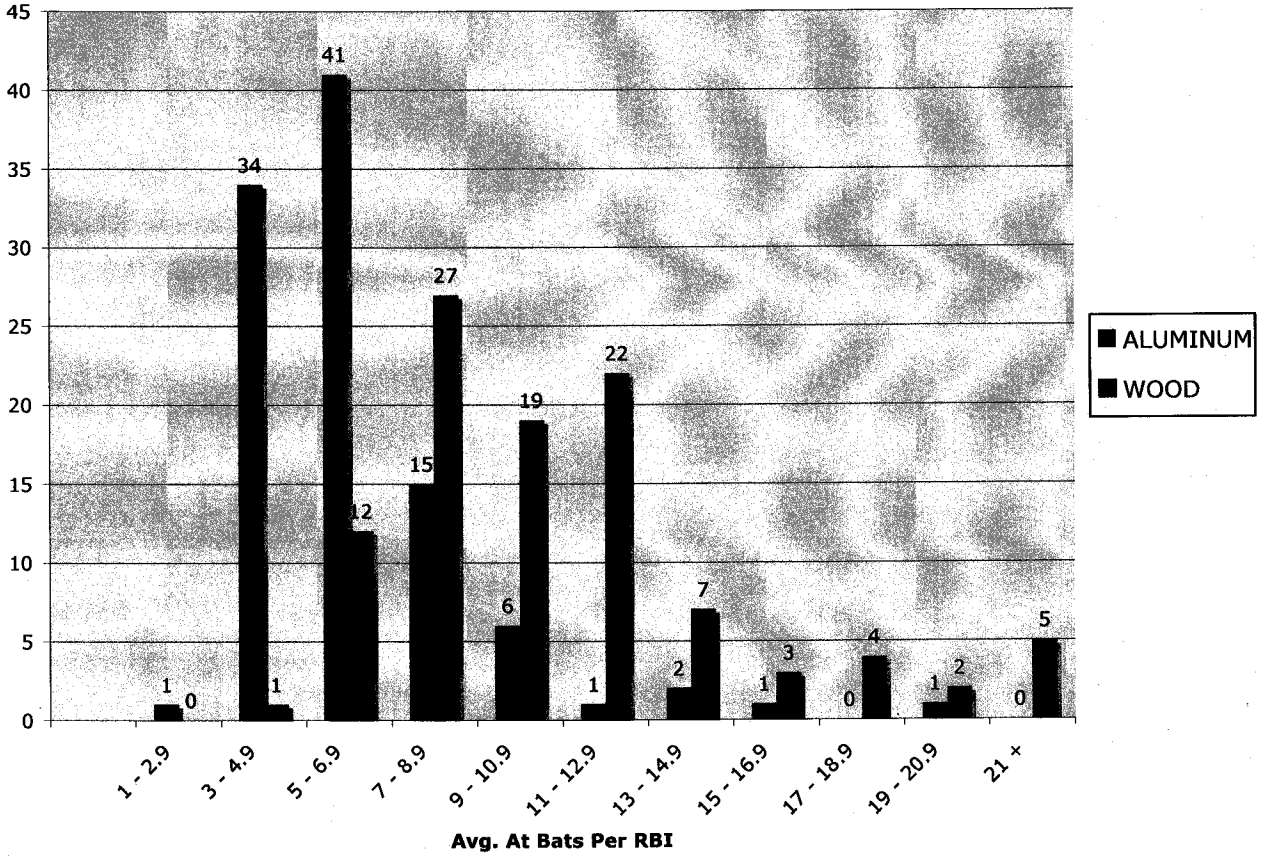
Using Aluminum:
- 47% of hitters score a run in under 5 at bats
- 2% of hitters needed 9 or more at bats to produce a run

Using Wood:
- 4% of hitters score a run in under 5 at bats
- 37% of hitters needed 9 or more at bats to produce a run

Comparison of Aluminum to Wood Bat Performance

By Runs Batted In

2006 Season

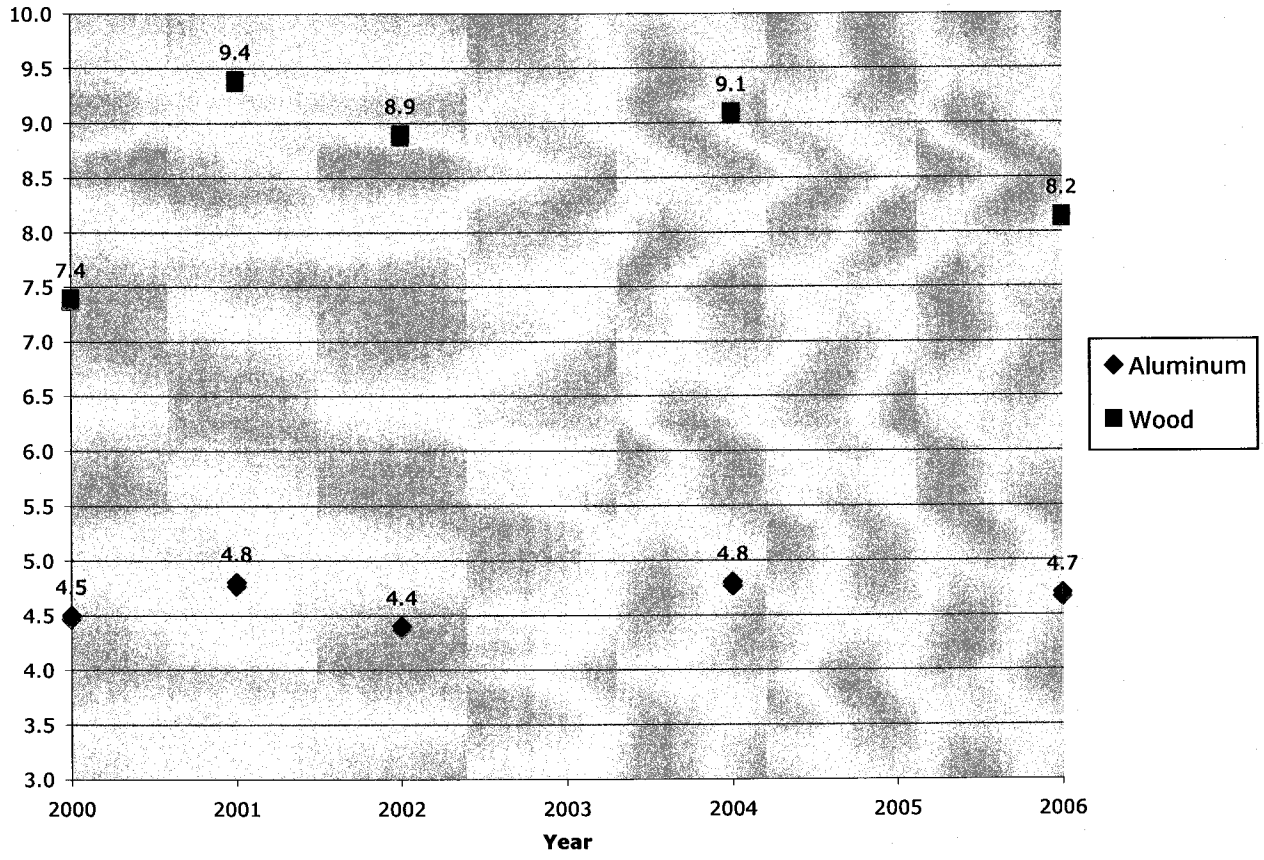


Avg. At Bats Per RBI	Aluminum		Wood	
	Hitters	Percent	Hitters	Percent
1 - 2.9	1	1%	0	0%
3 - 4.9	34	33%	1	1%
5 - 6.9	41	40%	12	12%
7 - 8.9	15	15%	27	27%
9 - 10.9	6	6%	19	19%
11 - 12.9	1	1%	22	22%
13 - 14.9	2	2%	7	7%
15 - 16.9	1	1%	3	3%
17 - 18.9	0	0%	4	4%
19 - 20.9	1	1%	2	2%
21 +	0	0%	5	5%

Using Aluminum:
- 75% of hitters drove in a run in under 7 At Bats

Using Wood:
- 13% of hitters drove in a run in under 7 At Bats

5 Season Trend
Comparison of Aluminum to Wood Bat Performance
By Runs Scored

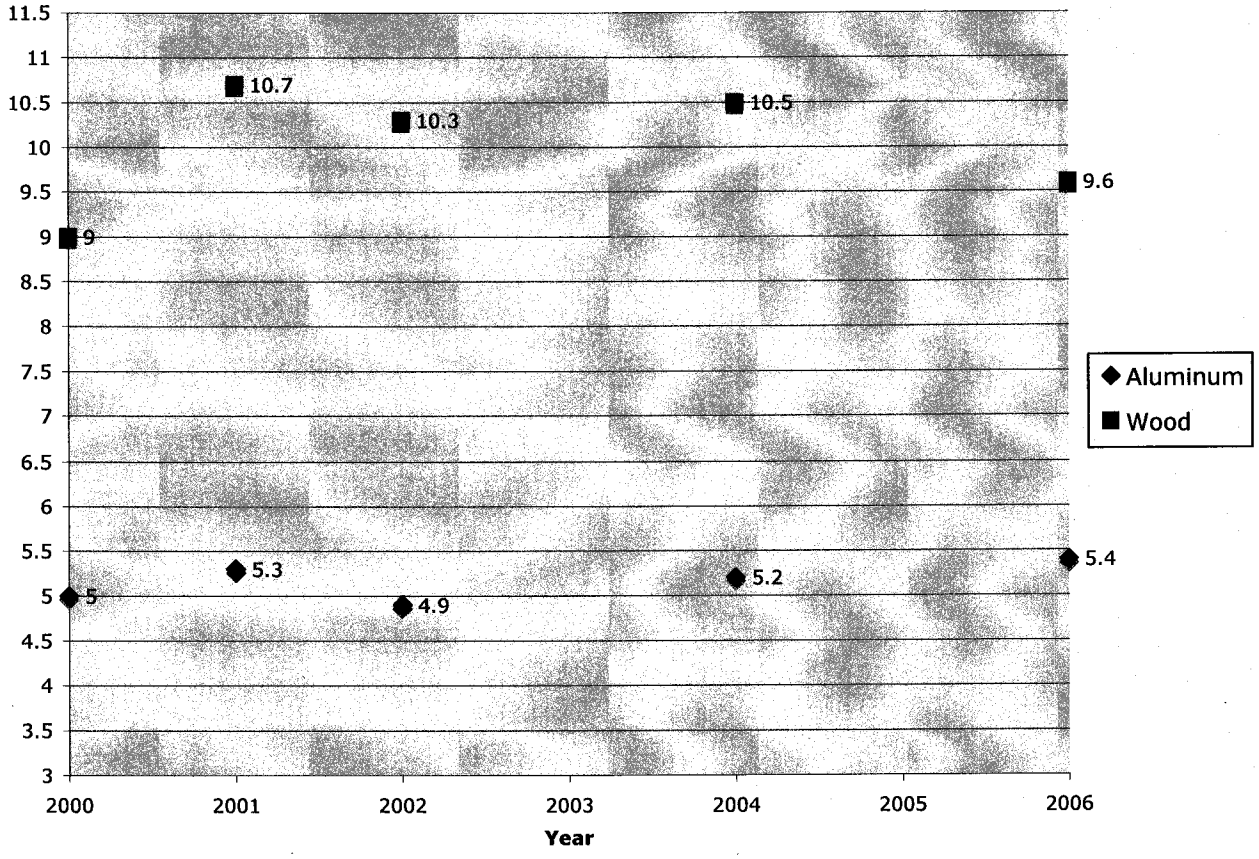


Runs Scored (per average number of at bats)

Year	Aluminum	Wood	Difference using wood
2000	1/4.5	1/7.4	-39%
2001	1/4.8	1/9.4	-49%
2002	1/4.4	1/8.9	-52%
2003	-	-	-
2004	1/4.8	1/9.1	-47%
2005	-	-	-
2006	1/4.7	1/8.2	-45%
Approx. 5 Year Avg.	1/4.6	1/8.6	-46%

This study was not conducted in 2003 and 2005.

5 Season Trend
Comparison of Aluminum to Wood Bat Performance
By Runs Batted In (RBI)



Runs Batted In (per average number of at bats)

Year	Aluminum	Wood	Difference using wood
2000	1/5.0	1/9.0	-45%
2001	1/5.3	1/10.7	-51%
2002	1/4.9	1/10.3	-52%
2003			
2004	1/5.2	1/10.5	-51%
2005			
2006	1/5.4	1/9.6	-44%
Approx. 5 Year Avg.	1/5.2	1/10.0	-48%

This study was not conducted in 2003 and 2005.

Performance of Pitchers

A 2006 Comparative Study

During the 2006 Cape Cod League season there were **71 Division I pitchers** who pitched at least a **minimum of 25 innings** and who also pitched for their college team in the spring of 2006.

Based on the number of innings pitched during the college season, **41 of the 71** pitchers were ranked number 1 to 3 on their staff; **25** pitchers were number 4 to 6; and **5** were numbers 7 thru 11 on their college staff.

One needs to realize that when pitching versus hitters using wood bats in the Cape Cod League, they were competing against the best hitters of 65 different Division I programs. Thus you have **better pitchers** facing **better hitters** than occurs during the collegiate season.

Another factor is that the Cape Cod League has used the **Diamond D 1 Pro baseball** (a livelier ball) during all the years of the study. In the year 2000 the NCAA adopted the **Rawlings Collegiate baseball** and lowered the COR (co-efficient of restitution rule) which made the ball much **less lively** than the Diamond, Wilson, or Spalding, or the Rawlings Major League baseball.

Yet, in spite of these factors, every year of the **8 year** study, **when pitching against wood bats, college pitchers:**

- **had lower earned run averages (ERA)**
- **allowed fewer hits per 9 innings pitched**
- **averaged striking out 5 to 9% more batters**

Conversely, when these same pitchers pitched against college teams which had many less-talented hitters in their line-ups than the Cape Cod League teams, **versus aluminum bats, the pitchers**:

- **E.R.A. increased**
- **hits allowed increased**
- **strike outs decreased**

It is obvious that a batter can control (swing) the aluminum bat more efficiently which is demonstrated by consistently higher batting averages and generate higher bat speeds (the major factor in creating batted ball exit velocity) which drives the ball with greater velocity and for more distance. **The increase in batted ball exit speed off aluminum bats increases the probability and risk of injury to a defensive player,** (particularly the pitcher), because players have less time to react and defend themselves than against balls hit off wood bats.

I. E.R.A. of 71 Division I pitchers who pitched at least a minimum of 25 innings in the Cape Cod League during the 2006 season.

ERA	Pitching vs. **Aluminum Bats**		Pitching vs. **Wood Bats**	
	Pitchers	Percent	Pitchers	Percent
7.00 – Plus	**1**	1%	**3**	4%
6.00 – 6.99	**3**	4%	**1**	1%
5.00 – 5.99	**11**	15%	**3**	3%
4.00 – 4.99	**22**	31%	**5**	7%
3.00 – 3.99	**24**	34%	**22**	31%
2.00 – 2.99	**10**	14%	**25**	35%
1.00 – 1.99	**0**	0%	**11**	15%
0.00 – 0.99	**0**	0%	**1**	1%
	71		71	

Vs. Aluminum Bats:
- **37%** of pitchers had an ERA over 4.00
- **10%** of pitchers had an ERA under 3.00
- The average ERA was **4.03**
- All pitchers average giving up **9.1 hits** per 9 innings.

Vs. Wood Bats:
- **17%** of pitchers had an ERA over 4.00
- **52%** of pitchers had and ERA under 3.00
- The average ERA was **3.05**
- All pitchers averaged giving up **7.6 hits** per 9 innings.

II. Hits Allowed per 9 innings Pitched

Hits Allowed	Pitching vs. **Aluminum** Bats		Pitching vs. **Wood** Bats	
	Pitchers	%	Pitchers	%
15 – 15.9	**0**	0%	**1**	1%
14 – 14.9	**1**	1%	**0**	0
13 – 13.9	**0**	0	**1**	1%
12 – 12.9	**1**	1%	**1**	1%
11 – 11.9	**3**	4%	**0**	0
10 – 10.9	**12**	17%	**3**	4%
9 – 9.9	**24**	34%	**10**	14%
8 – 8.9	**14**	20%	**15**	21%
7 – 7.9	**11**	15%	**20**	28%
6 – 6.9	**4**	6%	**8**	11%
5 – 5.9	**1**	1%	**5**	7%
4 – 4.9	**0**	0%	**7**	10%
	71		**71**	

Vs. Aluminum Bats:
- **42%** of pitchers allowed **less than a hit per inning.**
- **7%** of pitchers allowed fewer than **7 hits per 9 innings.**
- **24%** of pitchers allowed **10 or more hits per 9 innings.**

Vs. Wood Bats:
- **77%** of pitchers allowed **less than a hit per inning.**
- **28%** of pitchers allowed fewer than **7 hits per 9 innings.**
- **8%** of pitchers allowed **10 or more hits per 9 innings.**